deuterium and tritium, are the fuels of greatest interest. Temperatures of several million degrees are required to initiate the fusion reactions, however, hence the name "thermonuclear" reaction. Presently, thermonuclear explosives use the fission reaction to produce temperatures high enough to start the fusion reaction. The relatively low cost of thermonuclear fuels enables the yield of an explosive to be increased one hundredfold, from 10 kilotons* to 1 megaton,† at less than double an increase in cost.

The nuclear explosion

Nuclear explosions are characterized by the extremely high temperatures and pressures associated with a nearly instantaneous release of large quantities of energy. The temperatures are so extreme that all materials subjected to them have the properties of an ideal gas consisting of electrons and positive ions. These gases at high temperature and pressure expand rapidly giving rise to a pressure, or shock, wave in the surrounding medium, for example, the surrounding rock in underground explosions. In an underground explosion the gas continues to expand until the pressure is balanced by the weight and strength of the overlying rock or until the ground surface is broken.

Nuclear excavation

Figure 1 illustrates the cross section of a typical nuclear crater and defines some necessary terms. Figure 2 illustrates the effect of the depth at which the explosive is buried upon the crater's size and shape. Maximum crater dimensions result if the nuclear explosive is buried at the optimum depth, as indicated.

A nuclear explosive detonated at the ground surface will form a crater primarily by compaction and plastic deformation of the local material as a result of the high pressures previously described. This is a very inefficient way to use the energy released for excavation since most of the energy dissipates to the atmosphere in the form of radiant energy and blast. The radioactivity produced in the explosion is also almost entirely released into the atmosphere.

**An energy equivalent to 10,000 tons of TNT.*
†An energy equivalent to one million tons of TNT.